CONTRIBUTIONS

FROM THE

CUSHMAN LABORATORY

FOR

FORAMINIFERAL RESEARCH

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CONTENTS

These contributions will be issued quarterly. They will contain short papers with plates, describing new forms and other interesting notes on the general research work on the foraminifera being done on the group by the workers in this laboratory. New literature as it comes to hand will be briefly reviewed.

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CONTRIBUTIONS FROM THE CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

60. A PECULIAR CLAVULINA FROM THE UPPER CRETACEOUS OF TEXAS

By JOSEPH A. CUSHMAN

The species of *Clavulina* described here is a very peculiar one in its shape. It is evidently a specialized development which soon became extinct, as so far as is known, it is limited to a relatively narrow vertical range in the Navarro, the upper formation of the Cretaceous of Texas. It occurs with the striking species *Vaginulina webbervillensis* Carsey but probably has a shorter vertical range. The geographic range of this *Clavulina* was considerable as it is found in surface outcrops and cores over a wide area. It is a very curious modification of the genus but preserves the essential characters of *Clavulina*.

CLAVULINA COMPRESSA Cushman, new species
Plate 8, figures 1, 2

Test elongate, about twice as long as broad, all but the early portion much compressed, the early portion triangular in section, pointed at the initial end, later portion uniserial, plano-convex, one side continuing the flat side of the early portion, the opposite side slightly convex; chambers distinct; sutures distinct, slightly depressed; wall finely arenaceous, with much cement, the surface smoothly finished; aperture elongate, elliptical or crescentic. Length up to 1.60 mm.; breadth 0.80 mm.

Holotype (Cushman Coll. No. 9193) from the Navarro formation, core from the upthrow side of the Mexia fault, Mexia, Texas, at 482 feet.

In this core the species was observed from 359 feet to 372 feet below the top of the Navarro coming in above the Nacatoch Sand. In outcrop material it occupies a similar position in the known section as well as in other cores. It is a very interesting species in its modifications of the usual structure of *Clavulina*.

61. ADDITIONAL CISCO FORAMINIFERA FROM TEXAS

By JOSEPH A. CUSHMAN and JAMES A. WATERS

The following species have been noted among others from the Cisco division of the Pennsylvanian of Texas:

TOLYPAMMINA DELICATULA Cushman and Waters, new species
Plate 8, figure 3

Test attached, the early portion coiled in a regular planispiral manner with several coils, later becoming uncoiled and nearly straight if on a large surface, the tubular chamber at first very slender but the uncoiled portion in adults becoming larger and often very long compared to the coiled portion; wall distinctly arenaceous usually of more or less even angular grains but firmly cemented; aperture formed by the open end of the tube. Diameter of coiled portion usually not more than 0.10 mm. but entire test may be several millimeters in length.

Holotype (Cushman Coll. No. 9154) from the Graham formation of the Cisco, 5 feet above the Gunsight limestone, Graham, Young Co., Texas, attached to shell fragments.

This species is a very distinctive one with its very small but regularly coiled early portion and abrupt change to the straight uncoiled portion.

SPIROPLECTAMMINA CASTENSIS Cushman and Waters, new species
Plate 8, figures 4 *a*, *b*

Test broad, much compressed, about twice as long as wide; chambers in the early portion planispirally coiled, later ones

biserial; sutures only slightly depressed; wall arenaceous, of a mixture of coarse and fine grains making a rough surface, firmly cemented; aperture elongate, arched, at the center of the inner margin of the final chamber. Length 0.75 mm.; breadth of 0.40 mm.; thickness 0.06 mm.

Holotype (Cushman Coll. No. 9150) from the Pueblo formation of the Cisco, from the Camp Colorado limestone, about 1½ miles Northeast of Camp Colorado, Coleman Co., Texas.

This is an unusually broad flattened form with the coiled portion making up a large part of the test.

BIGENERINA CISCOENSIS Cushman and Waters, new species
Plate 8, figures 5 *a*, *b*

Test small, elongate, the early portion compressed and tapering, the chambers biserial, later portion with the sides nearly parallel, of a few, 3-5, uniserial chambers in a rectilinear series; early chambers broad and low, increasing gradually in height as added, later uniserial chambers nearly as high as broad; sutures distinct, only slightly depressed; wall rather coarsely arenaceous but the angular grains neatly fitted and the surface fairly smooth, firmly cemented; aperture large for the size of the chamber, elliptical, terminal. Length 0.45-0.50 mm.; breadth 0.12-0.15 mm.

Holotype (Cushman Coll. No. 9183) from the Graham formation of the Cisco, from a sandy, lignitic shale, 2½ feet below the Gunsight limestone, 1 mile West of Graham, Young Co., Texas.

GEINITZINA CISCOENSIS Cushman and Waters, new species
Plate 8, figures 6 *a*, *b*

Test cuneiform in front view, compressed, tapering gradually from the initial end, greatest breadth at the apertural end, periphery rounded; sutures indistinct, very slightly depressed; wall finely arenaceous, rather smoothly finished; aperture elongate, elliptical or even linear and more or less zig-zag in shape. Length 0.60 mm.; breadth 0.30 mm.; thickness 0.06 mm.

Holotype (Cushman Coll. No. 9154) from the Upper Cisco, from the Pueblo formation, taken from the Camp Colorado limestone, about 1½ miles Northeast of Camp Colorado, Coleman Co., Texas. This is one of the earliest occurrences in the

Texas Pennsylvanian of this genus which is largely Permian in its range.

This species is primitive in its larger amount of arenaceous material, more evenly tapering form with the increase in width continuing throughout most of the life instead of the later half having parallel sides as in the typical Permian forms.

Genus APTERRINELLA Cushman and Waters, new genus

Genoholotype, *Tolypammina grahamensis* Harlton

Test attached, consisting of a proloculum and tubular second chamber with the early portion coiled about the proloculum, then uncoiling and wandering about over the surface to which it is attached; wall calcareous, imperforate; aperture semicircular, formed by the open end of the tubular chamber.

Pennsylvanian.

This is a primitive attached genus derived from such genera as *Hemigordius* or *Cornuspira* becoming attached and then wandering about over the surface. The test especially in the young where the wall is thin has the characteristic bluish-white appearance so common in this family of the Ophthalmidiidae.

GLOBIVALVULINA BISERIALIS Cushman and Waters, new species

Plate 8, figures 7 *a-c*

Test essentially biserial, the early portion covered by the later coils, whole test hemispherical, chambers added alternately on either side of an elongate axis, each strongly overlapping the preceding ones; chambers from the surface elongate, elliptical, due to the overlapping; sutures depressed, distinct; wall finely arenaceous, smoothly finished; aperture on the ventral side of the test in a broad depression with a distinct valvular projection of the chamber. Diameter 0.50 mm.; height 0.22 mm.

Holotype (Cushman Coll. No. 9184) from the Graham formation of the Cisco, from the Bunger limestone, 3.2 miles Northeast of South Bend, Young Co., Texas.

This species may be distinguished from the others of the genus by the peculiar "braided" appearance, all the chambers, even the last-formed one, being on opposite sides of the nearly straight axis.

This and the following species differ from *G. gaptankensis*

Harlton and *G. bulloides* (H. B. Brady) both of which also occur in the Cisco of Texas.

GLOBIVALVULINA OVATA Cushman and Waters, new species
Plate 8, figures 8 *a-c*

Test mainly biserial, the whole test ovate, chambers except the final one added alternately on either side of an elongate axis, each slightly overlapping the preceding ones; chambers from the surface broadly elliptical; sutures depressed, distinct; wall finely arenaceous, smoothly finished; aperture on the ventral side of the test in a very broad depression, with a slight valvular projection. Diameter 0.50 mm.; height 0.30 mm.

Holotype (Cushman Coll. No. 9186) from the Graham formation of the Cisco, from 1 foot below the Gunsight limestone, 1 mile West of Graham, Young Co., Texas.

This species may be distinguished from the preceding by the final chamber extending clear across the periphery breaking the biserial series, the broader exposure of the chambers on the surface due to the slighter overlap.

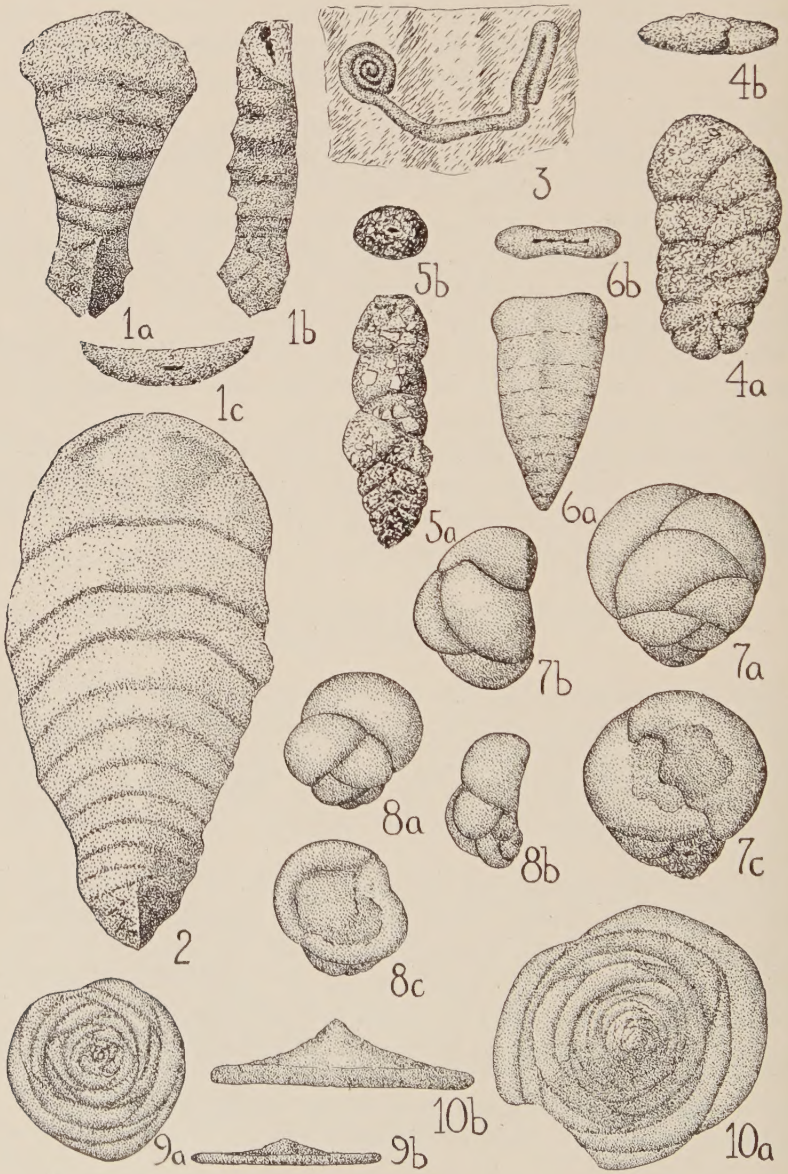
TETRATAXIS SCUTELLA Cushman and Waters, new species
Plate 8, figures 9 *a, b*

Test low and scale-like, the central portion barely raised above the general almost flattened surface; chambers elongate and narrow arranged throughout the adult stage in series of four, distinct; sutures distinct, often sharply depressed; wall with a fine arenaceous exterior, smoothly finished. Diameter 0.80 mm.; height 0.12 mm.

Holotype (Cushman Coll. No. 9179) from the Graham formation of the Cisco from 1 foot below the Gunsight limestone, 1 mile West of Graham, Young Co., Texas. It has a very much depressed spire and the chambers are very distinct. While such species assume somewhat the form of *Polytaxis*, they do not depart from the character of having the chambers in series of four.

TETRATAXIS CORONA Cushman and Waters, new species
Plate 8, figures 10 *a, b*

Test with the central portion high, rounded conical, the later portion spreading, in side view concave; chambers of the early portion less distinct than the later, spreading ones, early develop-


1a
1b
1c
2
3
4a
4b
5a
5b
6a
6b
7a
7b
7c
8a
8b
8c
9a
9b
10a
10b

ing in four series; sutures distinct in later development, slightly depressed, less distinct in the early portion; wall fairly smooth, the outer arenaceous layer more marked in the conical young. Diameter 0.50 mm.; height 0.20 mm.

Holotype (Cushman Coll. No. 9174) from the Graham formation of the Cisco from 5 feet above the Gunsight limestone, 1 mile West of Graham, Young Co., Texas. The species occurs as high in the Cisco as the Camp Colorado limestone of the Pueblo formation, 1½ miles Northeast of Camp Colorado, Coleman Co., Texas.

This is a very fine little species with the early portion in a rounded conical shape and the later chambers flaring. It does not attain a large size.

EXPLANATION OF PLATE 8

All figures × 80 except Fig. 5. × 135

FIGS. 1, 2. *Clavulina compressa* Cushman, n. sp. Fig. 1, Holotype. *a*, front view; *b*, side view; *c*, apertural view.

FIG. 3. *Tolypammina delicatula* Cushman and Waters, n. sp.

FIG. 4. *Spiroplectammina castensis* Cushman and Waters, n. sp. *a*, front view; *b*, apertural view.

FIG. 5. *Bigenerina ciscoensis* Cushman and Waters, n. sp. *a*, front view; *b*, apertural view.

FIG. 6. *Geinitzina ciscoensis* Cushman and Waters, n. sp. *a*, front view; *b*, apertural view.

FIG. 7. *Globivalvulina biserialis* Cushman and Waters, n. sp. *a*, dorsal view; *b*, side view; *c*, ventral view.

FIG. 8. *Globivalvulina ovata* Cushman and Waters, n. sp. *a*, dorsal view; *b*, side view; *c*, ventral view.

FIG. 9. *Tetrataxis scutella* Cushman and Waters, n. sp. *a*, dorsal view; *b*, side view.

FIG. 10. *Tetrataxis corona* Cushman and Waters, n. sp. *a*, dorsal view; *b*, side view.

62. THE MICROSPHERIC AND MEGALOSPHERIC FORMS OF APTERRINELLA GRAHAMENSIS

By Joseph A. Cushman

This species was described by Harlton as *Tolypammina grahamensis* (Journ. Pal., Vol. 1, No. 4, 1928, p. 305, pl. 52, fig. 1). I have examined the holotype as the original description is somewhat vague in certain points. The proloculum is described as "round, coiled". There is a great deal of difference in the microspheric and megalospheric forms as will be noted, the proloculum itself being generally globular as in most other foraminifera. The wall is described as "finely arenaceous". This form belongs to the Ophthalmidiidae, and the wall is calcareous and imperforate although as Harlton notes "The surface of the test is finely granular. In most cases the granules are so minute and regular as to be readily mistaken for perforations." The statement "The early stages of the test are peculiarly constructed and often obscured" needs elucidation.

The species occurs in enormous numbers attached to *Myalina* and other shells. In the microspheric form shown in pl. 9, fig. 1, the early coils following the very small globular proloculum are regular and close coiled on the surface of attachment. The wall is thin, smooth and imperforate, and of secreted calcareous material as in *Cornuspira*. The whole tube has the milky-white appearance so characteristic of the members of the Ophthalmidiidae in Recent and Jurassic species. After several closely set coils the tubular chamber uncoils and winds about over the surface of attachment. Very often these early stages occur in such great numbers as to entirely cover the original surface of attachment and pile up on one another several deep. These resemble the mass of tubes figured by Howchin (Journ. Roy. Micr. Soc., 1888, pl. 8, fig. 3) as *Hyperammina vagans* from the Carboniferous of Australia. When these tubular tests massed upon a small object, they often completely covered it with these intertwined tubes. The single specimens such as figured here (pl. 9, fig. 1) are very similar to that figured by Brady (Pal. Soc. Mon. 30, 1876, pl. 3, fig. 16) as "*Trochammina filum* Schmid". In the

megalospheric forms with the proloculum of medium size (pl. 9, fig. 3) there is a smooth globular proloculum followed by a single coil, more or less before the uncoiling begins. Here the smooth proloculum is followed by the "granular" wall noted by Harlton. The surface of the test is really pitted, and forms a more or less regular network of raised ridges about the depressions. In the microspheric form this is not taken on until some considerable length of smooth tube is developed. In later development the test winds irregularly over the surface of attachment and becomes large as in pl. 9, fig. 2, the sides flattened and flange-like.

In the specimens with a very large megalospheric proloculum (pl. 9, fig. 4), the globular proloculum is again smooth and stands up above the rest of the test. It is followed by a partially coiled tubular chamber which is coarsely reticulate immediately following the proloculum and develops the lateral flange. In other words it takes on the adult characters immediately following the proloculum, leaving out the stage of numerous close coils and winding tube with a smooth surface seen in the microspheric form. If the stages were not present and the specimens in such enormous numbers as to give all stages in the development, it might be thought that more than a single species was present.

This species gives an excellent example of Hofker's "Trimorphism", and shows the necessity of studying large series of both microspheric and megalospheric forms of the species before a truly adequate idea of the full characters can be determined.

The species is a striking one, and has a wide range in the Upper Pennsylvanian of Texas and Oklahoma and probably elsewhere.

63. A CRETACEOUS CYCLAMMINA FROM CALIFORNIA

By Joseph A. Cushman

Through the kindness of Dr. Hubert G. Schenck of Stanford University, I have a series of the following species of *Cyclammina* from below known Eocene sediments. The species is a fairly large one and has more and higher chambers than in most of the other known Cretaceous species. The specimens are apparently silicified, and take much grinding to prepare sections. The interior is labyrinthic, but the aperture could not be made out clearly being fused in all cases although there are indications of its characters. The species is named for Dr. Schenck.

CYCLAMMINA SCHENCKI Cushman, new species
Plate 9, figures 5 *a*, *b*

Test comparatively large, close coiled, compressed, umbilicate, periphery rounded; chambers numerous, 12 or more in the last formed coil, fairly distinct, but little inflated; sutures very slightly depressed, very slightly curved; wall finely arenaceous with much cement, the interior of the test labyrinthic, surface smoothly finished; aperture evidently consisting of a narrow arched slit at the base of the apertural face and indications of small circular pores in the middle of the apertural face. Length 2 mm.; breadth 1.75 mm.; thickness 0.60 mm.

Holotype from the Mt. Pinos Quadrangle of California, Leland Stanford Junior University locality 668 from a black shale from below Tejon Eocene sandstone at Topatopa Bluff, Ventura Co., California, perhaps of Cretaceous age.

There are numerous specimens in the collection sent me, all apparently of one species. I have collected this species from other localities in California, and Dr. Schenck has also had it from similar shales as he will note later. It is evidently a rather widely distributed species and may make a good horizon marker for this particular formation.


5a
5b
1
3
4
2

EXPLANATION OF PLATE 9

FIGS. 1–4. *Apterrinella grahamensis* (Harlton). Fig. 1, Microspheric young
Fig. 2, Complete specimen with smooth early stage. Fig. 3
Megalospheric young with early coil. Fig. 4, Megalospheri
young with very large proloculum and adult characters com
mencing directly after the proloculum is formed.

FIG. 5. *Cyclammina schencki* Cushman, n. sp. × 50. *a*, side view; *b*
outline of apertural view.

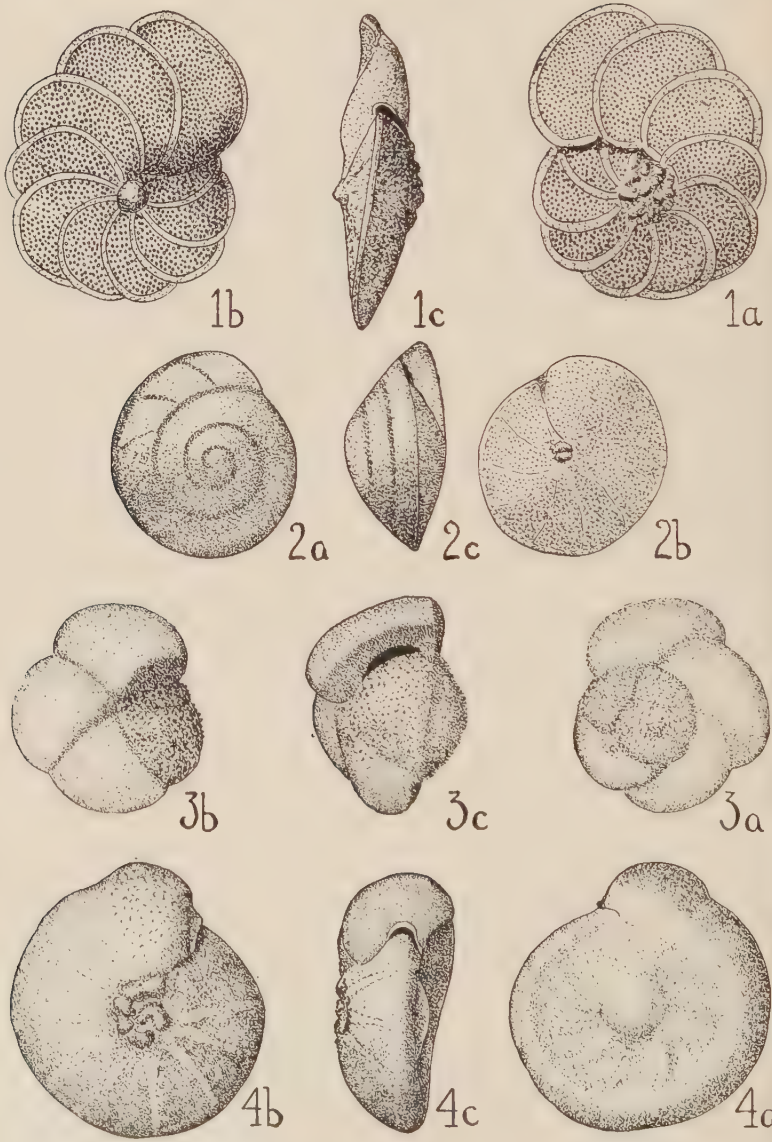
64. ADDITIONAL FORAMINIFERA FROM THE UPPER EOCENE OF ALABAMA

By Joseph A. Cushman

In Volume 1, Part 3 of these Contributions, October 1925, I described and figured a number of species of foraminifera from the upper Eocene of Cocoa Post Office, Alabama. The foraminifera in the Cocoa sand are very abundant and wash out very cleanly in enormous numbers. This is the type locality for *Hantkenina alabamensis* Cushman now known to have a wide distribution in the American upper Eocene. There are a number of other species which are also very abundant which are noted here. The material is perfectly preserved and all details are as sharp as in recent specimens. The fauna shows that the deposit is one of comparatively deep water. There is a great abundance of *Bulimina* and *Uvigerina,* numerous *Nodosaria* and *Dentalina,* and many of these species of *Planulina, Anomalina, Globorotalia* and *Eponides.* It is in this deposit that the bones of the cetacean *Zeuglodon* occur. There are very few Miliolidae but numerous *Globigerina.* The only species of the Miliolidae at all common is a *Massilina* allied with a species now found in the Gulf of Mexico in comparatively deep water.

EPONIDES COCOAENSIS Cushman, new species
Plate 10, figures 2 *a-c*

Test small, low conical, the ventral side only slightly convex, the dorsal side more strongly so, but the spire rounded and the periphery acute; chambers numerous but not inflated, about 12 in the last-formed whorl in the adult, all but the last few indistinct from the dorsal side; sutures on the ventral side nearly radiate, slightly curved, very slightly depressed, the central region with usually two slight bosses, dorsal side with the spiral suture distinct and somewhat limbate, the periphery strongly marked, sutures between the chambers oblique, not depressed, the last few distinct; wall calcareous, perforate, smooth except for the ventral bosses, ventral side coarsely perforate; aperture


1b
1c
1a
2a
2c
2b
3b
3c
3a
4b
4c
4a

ventral to the periphery, narrow. Diameter 0.35 mm.; height 0.18 mm.

Holotype from the Eocene, Cocoa sand of Cocoa Post Office, Alabama.

This is a small but distinct species abundant at this locality.

GLOBOROTALIA COCOAENSIS Cushman, new species
Plate 10, figures 3 *a-c*

Test small, with a low rounded spire, ventral side strongly convex, periphery rounded; chambers very distinct, four usually making up the last-formed chamber, inflated, earlier ones more globular than the later ones; sutures very distinct on the dorsal side, oblique and curved, ventrally nearly straight, radiate, deeper, depressed; wall in the early chambers rough and almost spinose, in the last ones nearly smooth, calcareous, perforate; aperture about midway between the umbilicus and periphery, an elongate, arched opening. Diameter 0.35 mm.; height 0.25 mm.

Holotype from the Eocene, Cocoa sand of Cocoa Post Office, Alabama.

It is common at the type locality and found elsewhere in the American upper Eocene. The species is closely related to *Globorotalia canariensis* (d'Orbigny) and *G. crassa* (d'Orbigny) but greatly differs from these in the relative shape of the test and the form of the individual chambers.

ANOMALINA COCOAENSIS Cushman, new species
Plate 10, figures 4 *a-c*

Test plano-convex, ventral side broadly convex, dorsal side flattened or even somewhat concave, the ventral side with a series of irregularly shaped bosses in a cluster in the umbilical region, the dorsal side with a low spire appearing almost as a low smooth boss, the area about depressed and then rising to the

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EXPLANATION OF PLATE 10

All figures × 90. *a*, dorsal, *b*, ventral, *c*, peripheral views.

FIG. 1. *Planulina cocoaensis* Cushman, n. sp.
FIG. 2. *Eponides cocoaensis* Cushman, n. sp.
FIG. 3. *Globorotalia cocoaensis* Cushman, n. sp.
FIG. 4. *Anomalina cocoaensis* Cushman, n. sp.

raised, rounded border, periphery broadly rounded; chambers 10-12 in the last-formed coil, fairly distinct; sutures on the dorsal side limbate and slightly raised, oblique and curved, on the ventral side the sutures limbate, not raised nor depressed, broadest near the inner end, nearly radial; wall calcareous, coarsely perforate, especially on the ventral side; aperture peripheral, small, arched, with a slight lip. Diameter 0.50 mm.; height 0.20 mm.

Holotype from the Eocene, Cocoa sand of Cocoa Post Office, Alabama.

This is one of the most abundant species of this locality and is a very finely marked one. The characters are remarkably constant and the species can be distinguished at once.

PLANULINA COCOAENSIS Cushman, new species
Plate 10, figures 1 *a-c*

Test much compressed, periphery acute and slightly keeled, central region of the ventral side occupied by a distinct, smooth, rounded boss, on the dorsal side the very low spire has numerous, small, raised protuberances; chambers 9-10 in the last-formed whorl, distinct, the last-formed ones slightly inflated especially on the ventral side; sutures very distinct, somewhat limbate on both sides, very slightly if at all depressed, curved on both sides; wall calcareous, coarsely perforate; aperture in the adult extending over onto the dorsal side of the test, elongate, narrow. Length 0.50 mm.; breadth 0.40 mm.; thickness 0.15 mm.

Holotype from the Eocene of the Cocoa sand, Cocoa Post Office, Alabama.

In order to gain some idea as to the relative abundance of the various constituents of the fauna of the Cocoa sand, a count was made of the specimens appearing in the field. Specimens of the washed sample were scattered over a tray and then the number in the field counted over various parts of the area. This was done until the total was five hundred. The following table shows the relative abundance of about twenty of the commoner species:

	%
Uvigerina jacksonensis	17.8
Bulimina jacksonensis	17.0
Globigerina sp.	12.6
Hantkenina alabamensis	9.6

Anomalina cocoaensis	7.0
Dentalina cocoaensis	6.4
Uvigerina cocoaensis	5.2
Planulina cocoaensis	4.6
Globorotalia cocoaensis	4.2
Siphonina jacksonensis	3.6
Robulus sp.	3.2
Eponides cocoaensis	3.2
Nodosaria jacksonensis	1.6
Robulus gutticostatus, var. *cocoaensis*	1.0
Nodosaria fissicostata	1.0
Marginulina cocoaensis	0.6
Massilina decorata	0.4
Clavulina sp.	0.4
Eponides jacksonensis	0.4
Nodosaria latejugata	0.2
	100.0%

The most common species is *Uvigerina jacksonensis*, which with *U. cocoaensis* makes up 23% or nearly ¼ of the whole foraminiferal fauna. The species of the Western Atlantic for which the most data is known is *Uvigerina peregrina* Cushman, a ribbed species related to these two ribbed ones of the Eocene. I have given the data for this species from 65 Albatross stations from the East coast of the United States. It ranges from 16 to 2,369 fathoms. Taking the 36 stations at which it is recorded as abundant, the range is from 136 to 1,731 fathoms and the average 942 fathoms.

The second commonest species is *Bulimina jacksonensis*. The nearest related living species are *B. buchiana* d'Orbigny and *B. rostrata* H. B. Brady. The former species is not common but is recorded with data from 8 stations in the Western Atlantic. These range from 193 to 1,742 fathoms, not common at any, but the largest number of specimens noted from the deepest station. The average of the 8 stations is 681 fathoms.

Of the other genera, *Globigerina* usually indicates deep water deposits and that the pelagic forms existed over the area. The same is true of *Globorotalia cocoaensis*. It is very probable that *Hantkenina* with its thin test, large aperture and spines may have been pelagic. *Siphonina* records are mostly from comparatively deep water. The only one of the Miliolidae is *Massilina*

decorata allied to species now living in comparatively deep water. The species of *Robulus, Nodosaria, Dentalina* and *Marginulina* all are related to species most abundant on the outer slope from the continental shelf in several hundred fathoms. In the entire list, there are no known shallow-water forms. It is, except for the fact that the species are extinct, such a faunal assemblage as might today occur in the Gulf of Mexico or on the Eastern coast of the United States in 500 fathoms. The relative abundance of pelagic forms indicates that open water conditions prevailed above the area of deposition.

The relationships of the fauna geographically in the Eocene are more difficult to determine. It is true that *Hantkenina* is widely distributed about the Gulf of Mexico in upper Eocene deposits. In the Chapapote formation of Mexico, Cole has recorded it as very common, and I have previously recorded it from Mexico from material probably of the same age. With it however the other species of the type locality do not seem to occur at least in any numbers. *Bulimina jacksonensis* is widely known but except in Texas does not seem to occur in any numbers with *Hantkenina alabamensis. Nodosaria jacksonensis* and *Uvigerina cocoaensis* are widely distributed in Texas and Mexico and probably elsewhere in the Eocene about the Gulf of Mexico but do not have with them various other species characteristic of the type locality. It would seem that the Cocoa sand at this type locality represents a faunal condition not usual in the Coastal Plain Eocene, and is probably a deeper water representative than most of the other Eocene of contemporaneous deposit.

It is very desirable to have a greater amount of data on living forms, and the work that I have initiated in the Atlantic work (Bull. 104, U. S. Nat. Mus.) should be carried out in other regions so that it may be easier to interpret from the foraminifera more definitely the depth and conditions of their deposition when dealing with Tertiary material. The number of genera which occur in the Coastal Plain Tertiary from the upper Eocene and also in the Recent deposits of the Gulf of Mexico and Eastern coast of the United States is a very large proportion. In many cases the species are either identical or closely allied with those of the same or other areas.

As has been previously noted the Tertiary foraminiferal faunas are usually closely related to Recent faunas of the same oceanic area. This is especially true of those faunal assemblages

whose habitat was outside of the 30 or 50 fathom mark. The shallow, shore faunas of the littoral zone have migrated often widely but the conditions off shore have remained much more stable and such forms have lived on with little disturbance of conditions and consequently little change in the faunal character for long periods. Our study of such phases of work with the foraminifera has only been started, but if carefully done, the results will have wide application to other problems of sedimentation and distribution.

65. ON FAUJASINA D'ORBIGNY

By J. HOFKER

(The Hague, Holland)

This peculiar genus, erected in 1839 by Alcide d'Orbigny (in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères", p. 109), shows the typical exterior structure of *Elphidium (=Polystomella)*, viz. the fine pores of the walls, its pustulate structure, the row of rounded apertures at the suture of the apertural face, the rows of openings of the canal system at each suture. The only difference between real *Elphidium* and *Faujasina* seems to be the trochoid shape of the latter.

Yabe and Hanzawa (Jap. Journ. Geol. Geog., Vol. 2, No. 4 1923, p. 99) described a typical genus, *Polystomellina*, very closely allied to *Faujasina*, the only real difference between these two genera being the fact that in *Faujasina* the whole series of chambers is visible from the flat side, in *Polystomellina* however from the convex one.

Cushman (Special Publ. No. 1, Cushman Lab. Foram. Res. 1928, pl. 28) has suggested that these two genera are derived from typical *Elphidium*, and not that *Elphidium* is derived from *Faujasina* or *Polystomellina*. I showed in my Siboga Monograph, that *Polystomella (=Elphidium)* must be considered as a higher specialized form of *Nonion (=Nonionina)*, especially in respect to the canal system. So it will be interesting to find whether the canal system of *Faujasina* is more like that of *Elphidium* or that of *Rotalia*, for, as I pointed out in the Siboga work, the canal system of *Elphidium* showed so much resemblance to that of *Rotalia*, that *Elphidium* has to be considered as a symmetrically developed *Rotalia*.

Therefore I suggested, that if Cushman's views were right, it would be very probable that the spiral canal is to be found at both sides of the test. If, however, *Faujasina* be considered as a primitive *Elphidium* (the link between *Elphidium* and *Rotalia*) the canal system would be present only at the ventral side; for I am convinced that the symmetrical shape has developed first

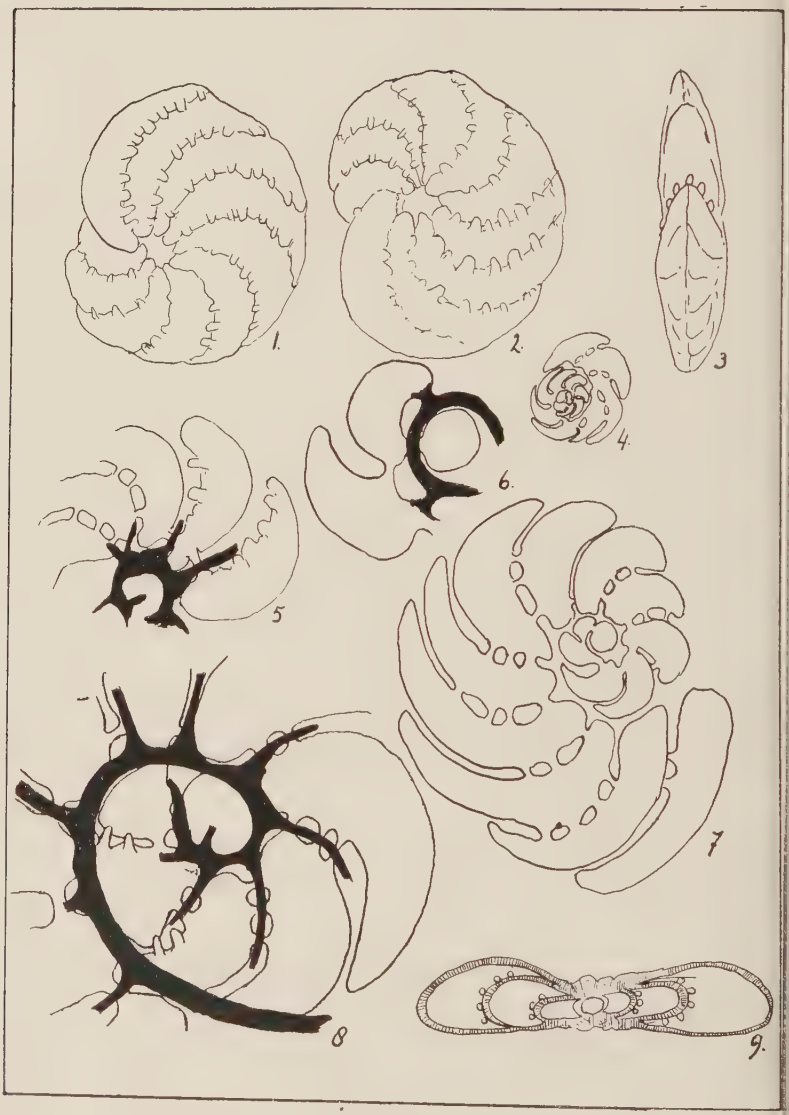
and that the second umbilical canal system has grown out afterwards.

Wanting some well preserved material to study, I wrote to J. A. Cushman, who was so kind as to send me some excellently preserved specimens of *Faujasina carinata* d'Orbigny.

Four specimens were megalospheric, and one was microspheric. The megalospheric ones were studied by means of my method with Canada balsam—impregnation. They showed a beautifully developed *Polystomella*-like canal system, which, at the side where only the last whorl of chambers is visible, existed as a broad and very well developed spiral canal, with the same structure as that of *Polystomella macella* (Monograph IV, Siboga Exped., pt. 1, 1927, pl. XXVI, fig. 5). At the other side, the dorsal one, the spiral canal is more narrow, but equally well developed. The two canals are connected by interseptal canals, which cannot be distinguished from those met with in *Elphidium*.

So I was sure that *Elphidium* is an ancestor of *Faujasina*. The study of the microspheric form gave a second argument: this form equally shows the somewhat trochoid shape, but the chambers are equitant and their ales on both sides reach the middle of the test, so that one cannot observe the earlier whorl on either side. Thus it is shown once more that the microspheric form always has primitive characteristics.

Conclusion: The development of the canal system and the *Elphidium*-like characteristics of the microspheric form affirm Cushman's views about the descent of *Faujasina*.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EXPLANATION OF PLATE 11

Faujasina carinata d'Orbigny

FIGS. 1–3. Microspheric form. × 120.

FIG. 4. Central part of horizontal section of microspheric form. × 150.

FIG. 5. Canal system of the ventral side. × 150.

FIG. 6. Central part of the canal system of the dorsal side, showing the *Rotalia*-like communication with the chambers. × 350.

FIG. 7. Canada balsam preparation of megalospheric form. × 150.

FIG. 8. Dorsal canal system. × 350.

FIG. 9. Transverse section through megalospheric specimen, ventral side above. × 150.